Corning Inc.: Proposed Changes at Glass Plant Indicate $26 Million in Potential Savings

Benefits

- Identified savings of $26 million annually in operating and energy costs
- Identified ways to reduce annual natural gas use by 123,000 MMBtu, reduce annual electrical use by 72.2 million kWh, and reduce annual CO_2 emissions by 180 million pounds
- Potential average payback period for all assessment recommendations of 5 months

Application

Glassmaking uses large amounts of natural gas and electricity and may release greenhouse gases such as CO_2 into the environment. The assessment showed that significant savings in costs and energy, as well as reduced emissions, are possible in such an energy-intensive industry. Furthermore, the projects identified can be implemented in other glass production plants and in other industries.

Summary

In the year 2000, the Corning glass plant in Greenville, Ohio, consumed almost 114 million kilowatt-hours (kWh) of electricity and nearly 308,000 million British thermal units (MMBtu) of natural gas in its glassmaking processes for a total cost of approximately $6.4 million. A plant-wide assessment of energy efficiency, emissions, and productivity was performed in an effort to discover ways to reduce energy use and costs and to decrease carbon dioxide (CO_2) emissions. The assessment indicated that a 40% reduction in natural gas and a 64% reduction in electricity could be achieved if certain changes were made to the plant and its processes.

Public-Private Partnership

The U.S. Department of Energy's (DOE) Industrial Technologies Program (ITP) cosponsored the assessment through a competitive process. DOE promotes plant-wide energy-efficiency assessments that will lead to improvements in industrial energy efficiency, productivity, and global competitiveness, while reducing waste and environmental emissions. In this case, DOE contributed $100,000 of the total $218,000 assessment cost.

Company Background

Corning, Inc., is a 150-year-old U.S.-based manufacturer of lighting products with several plants in North America. The Greenville, Ohio, plant was built in 1957 to manufacture automotive headlights. The plant primarily produced glass components for parabolic aluminized reflector lights, ultra-high precision (UHP) lights, and sealed-beam headlights. UHP lights are used in projectors and other high-tech applications; the market for these lights is growing. The market for sealed-beam headlights is declining.

The plant at Greenville encompassed approximately 150,000 square feet of warehouse and 250,000 square feet of manufacturing space on 35 acres and employed more than 350 people. It operated three 8-hour shifts per day, 7 days per week, 50 weeks per year. Each of the two melt furnaces had a capacity of about 100 tons per day. The furnaces used on-line measurement and control for continuous temperature and emissions monitoring. The melted glass (typically borosilicate glass) was fed into one of 12 multi-mold presses that typically formed the product in one stamping operation. The semi-finished product underwent subsequent processing operations and heat treatment. Packaging operators inspected and accumulated the final products into shipping containers for each customer.

Glassmaking is a highly energy-intensive process. The zoned furnace operated on a mix of 30% natural gas and 70% electricity, whereas the second furnace used 100% electricity for melting, except during startup. The plant had three gas-fired boilers to produce steam at an average rate of 5,000 pounds per hour. Five 450- to 250-horsepower (hp) (2300-volt [V]) motors and six 300- to 150-hp (480-V) motors generated compressed air at either 50 or 100 pounds per square inch. Four-hundred-watt high-pressure sodium vapor lights provided the primary illumination in the plant. Vacuum was supplied by five 25-hp piston vacuum pumps. Other large energy users included the 12 presses that formed the glass products.

Assessment Approach

The Greenville plant and the Edison Materials Technology Center (EMTEC) jointly conducted the plant-wide assessment. EMTEC has more than140 industry members, many of whom develop state-of-the art and emerging technologies that have significant potential to impact energy efficiency. Ohio's Energy Efficiency Office; Mid-West Building Diagnostics; D.L. Steiner; CSGI, Inc.; and Dr. Kelly Kissock of the University of Dayton formed the assessment team.

The assessment goals were to identify ways to increase the energy efficiency of the plant, reduce wastes and pollutants, and increase productivity. The assessment team examined all equipment and systems that used large amounts of energy for potential savings. The manufacturing process was studied to see if any lean-manufacturing improvements could be implemented. The team also evaluated demand-side energy management, best practices, emerging technology implementation, and supply-side options. The project's targets included 1) optimizing the electric boost to reduce the total energy consumption by 5%, 2) reducing operating costs by 10%, 3) improving manufacturing efficiency by 1% to 3%, 4) reducing press machine down time by 1% to 3%, and 5) reducing scrap rates by 10%.

One of the first tasks the assessment team completed was an inventory of gas-using equipment, air compressors, electrical equipment, and lighting fixtures in the plant. The team also tracked the plant's consumption of electricity, natural gas, water, and sewer services for a full year to help understand production trends and operating costs. Finally, the following systems were evaluated for potential energy savings.

Electrical systems. The plant's three-shift operation offered the opportunity to move noncontinuous operations with large electrical demand to off-peak periods.

Gas-fired boilers. The boilers were major users of primary energy resources and offered opportunities for efficient combustion, energy reduction in steam generation, heat recovery, air emission, and waste reduction.

Lighting. Old-style T12 lamps with magnetic ballasts illuminated many areas of the plant. As these ballasts failed, they were replaced with T8 lamps with electric ballasts that provided the same amount of light but used about 30% less energy.

Motor drive systems. Energy savings might be realized by utilizing premium efficiency motors, variable speed drives on the machinery, or notched v-belts.

Vacuum pumps. The team examined the vacuum system for potential savings by reducing vacuum loss in the distribution system, optimal staging of the pumps, and effective use of cooling air and water.

Air compressors. The air compressor system was evaluated for potential savings by using outside air, reducing the line pressure, reducing pressure loss in the distribution system, optimal staging of compressors, or effective use of cooling air and water.

Process heating. The team explored several possibilities for savings in the process heating system: 1) optimizing the combustion efficiency/design of the furnaces and heat treat ovens; 2) using waste heat to preheat the glass batch, supply heat to the heat treat oven, or preheat the combustion air; 3) optimizing the electric boost; 4) producing oxygen more efficiently for oxy-fuel firing; 5) using cogeneration and heat recovery; and 6) examining air handling and waste heat recovery.

Equipment. The presses and associated tooling and dies were investigated for optimal performance.

Results

The assessment team developed 17 assessment recommendations (ARs) that, if implemented, could have reduced waste, energy, and operating costs at the plant. These are listed in Table 1. The ARs covered a range of operations, from establishing a Lean Value Stream for the entire plant operation (AR 1) to installing photo sensors on outside lights (AR 17).

Table 1. Summary of Recommendations and Areas of Improvements

		Projected Annual Savings				Projected Economic Impact	
No.	Assessment Recommendation	Natural Gas (MMBtu)	Electricity (kWh x 10^6)	CO_2 (lb)[1]	Financial ($)	Capital Cost ($)	Payback Period (years)
1	Establish a Lean Value Stream[2]	N/A	12.5	28,500,000	23,688,000	6,544,000	0.3
2	Glass melter design options: rebuild zoned furnace with oxy-gas firing and 30% electric boost; batch preheated with waste heat from flue gases	78,000	17.8	49,600,000	920,000	1,250,000	1.4
3	Rebuild zoned furnace to use oxy-gas firing (no batch preheat)	37,000	20.4	51,100,000	612,000	1,004,000	1.6
4	Change electric furnace to use gas turbine to produce electricity for melter; recover heat from turbine exhaust to preheat glass batch and also supply heat to annealing lehrs (ovens)	20,000	6.7	17,500,000	270,000	732,000	2.7
5	Convert electric furnace from all-electric melting to combined electric melting with gas-fired glass batch preheater	-12,000	9.1	19,700,000	208,000	250,000	1.2
6	Replace 11 drilled blowoff pipes with air knives	N/A[3]	2.0	4,690,000	84,000	11,000	0.1
7	Replace 24 copper-tube open jets with nozzles	N/A	1.7	3,920,000	70,000	5,000	0.1
8	Improve power factor	N/A	(7,000 kVAr)[4,5]	N/A	20,000	65,000	3.2
9	Install variable speed drive on mold cooling fan motor	N/A	0.7	1,590,000	20,000	21,000	1.0
10	Lower the 100-psi compressed air system pressure by 10 psi	N/A	0.5	1,220,000	11,000	N/A	0
11	Replace T12 lights with energy-efficient T8 lights	N/A	0.2	436,000	8,000	5,000	0.6
12	Install variable speed drive on tooling cooling loop motor	N/A	0.2	502,000	8,000	10,000	1.2
13	Replace and downsize existing motors that show a payback of ≤ 5 years	N/A	0.1	204,000	3,000	13,000	3.7
14	Use notched V-belts on belt-driven applications	N/A	0.2	369,000	6,000	N/A	0
15	Install variable speed drive on machine cooling loop motor	N/A	0.1	332,000	5,000	15,000	2.8
16	Reuse boiler blowdown to produce low-pressure steam	N/A	N/A	51,000	3,000	5,000	1.8
17	Install photo sensors on outside lights	N/A	N/A	40,000	N/A	N/A	0
	Totals	**123,000**	**72.20**	**179,754,000**	**25,936,000**	**9,930,000**	**0.4**[6]

1 Assumes (2.3 lb of CO_2 per kWh of electricity) + (11.3 lb CO_2 per 100 ft^3 of natural gas)

2 Implementing a Lean Value Stream would require a five-phase project: (a) reduce inventory, (b) transport overseas shipments via air instead of sea, (c) institute a "pull system" of production scheduling, (d) increase quality yield of molded glass production, and (e) install a smaller furnace to decrease molten glass production.

3 N/A = not applicable

4 kVAr = kilovolt•ampere reactive

5 This number is not included in the total electricity savings

6 Aggregate average

The most ambitious proposal was to implement a Lean Value Stream in the plant (AR1). A Lean Value Stream Analysis (LVSA) identifies ways to eliminate wastes in an operation's core processes and increase the flow of products or services to the customer. In this case, the LVSA revealed several major opportunities to change business operations throughout the glass-making process, from installing a smaller furnace on the manufacturing side to changing the way the final product is shipped overseas. Implementing all the changes in AR 1 could have saved an estimated $24 million annually and reduced electricity use by 12.5 million kWh per year. With a capital cost of $6.5 million, the payback period would be about 4 months.

Another improvement involved the two melt furnaces that were relatively old. The plant considered rebuilding them, and several ARs were proposed to improve furnace performance during rebuilding. For each of these ARs, the economics and payback periods were very closely related to the cost of natural gas, electricity, and oxygen. The AR that would provide the greatest overall savings—in terms of natural gas and electricity use and financial savings—was to rebuild the zoned furnace to use oxy-natural gas firing with 30% electric boost and preheat the glass batch with the waste heat from the furnace flue gases (AR 2). The retrofit cost for the system included installation of the oxy-fuel system, modifications to the electric system, rebuilding the tank using a higher-grade refractory, and the batch preheating system. The system would not require a regenerator and the size of the emission control equipment (i.e., the baghouse for particulate control) would be greatly reduced. The team estimated that the annual savings for this project were approximately 78,000 MMBtu in natural gas, 18 million kWh in electricity, 50 million fewer pounds of CO_2 released into the atmosphere, and $920,000. The proposed system had the added value of increasing production on the order of 15% to 20%. With a capital cost of $1.25 million, this AR would have a simple payback period of 1.4 years.

Projects Identified

Table 1 lists the 17 ARs that were developed by the assessment team. Implementing all 17 ARs would save approximately $26 million annually in operating and energy costs, as well as reduce natural gas use by 123,000 MMBtu per year, reduce electrical use by 72.2 million kWh per year, and reduce CO_2 emissions by 180 million pounds per year.

BestPractices is part of the Industrial Technologies Program, and it supports the Industries of the Future strategy. This strategy helps the country's most energy-intensive industries improve their competitiveness. BestPractices brings together emerging technologies and energy-management best practices to help companies begin improving energy efficiency, environmental performance, and productivity right now.

BestPractices emphasizes plant systems, where significant efficiency improvements and savings can be achieved. Industry gains easy access to near-term and long-term solutions for improving the performance of motor, steam, compressed air, and process heating systems. In addition, the Industrial Assessment Centers provide comprehensive industrial energy evaluations to small- and medium-size manufacturers.

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